Efficient testing of multi-frequency, multi-constellation GNSS receivers

Simultaneous simulation of all important constellations and frequency bands makes the GNSS simulator in the R&S®SMW200A the perfect solution for testing your GNSS receiver in the lab.


Your task

All available GNSS, including modernized GPS, GLONASS, Galileo and BeiDou, already offer, or at least have planned, their positioning services on multiple frequencies in the L-band. Using various signals on different carriers helps to improve the position estimate (navigation solution) of a receiver significantly in terms of accuracy and reliability. This is because receivers working on L1 and L2 signals are able to calculate the ionospheric delay and, as a result, remove the corresponding position error. Considering all available GNSS, the total number of navigation satellites in space amounts to over 120. About 30 satellites are visible on average from most locations around the world. Each of these space vehicles (SV) provides multiple positioning services on different frequencies.

Additionally, the signals of the visible satellites are not only received via line of sight (LOS), but are also reflected from nearby buildings or other obstacles. Obviously, the requirements on the receiver side increase with the evolution in GNSS constellations, and realistic simulations become more complex and computationally expensive.

Engineers developing new receivers capable of multi-constellation signal processing require a highly accurate and also versatile simulator to validate functionality and performance. The simulator needs to be able to provide signals for any combination of GNSS (e.g. GPS, Galileo, GLONASS or BeiDou) and frequencies as realistically as possible. Therefore, its channel budget has to be large enough to cover all visible SVs, the high number of positioning services (such as L1 C/A or E1 OS) and also the reflected echoes. Additionally, engineers must be able to take account of signal propagation characteristics, such as tropospheric and ionospheric effects, system characteristics, such as orbit and clock errors, and the user environment, e.g. shadowing or other impairments.

Rohde & Schwarz solution

The advanced GNSS option, R&S®SMW-K120, turns the R&S®SMW200A vector signal generator into a powerful GNSS simulator and a compact solution for highly efficient GNSS receiver testing. The special GNSS advanced GUI makes setting up complex test scenarios simple and intuitive.
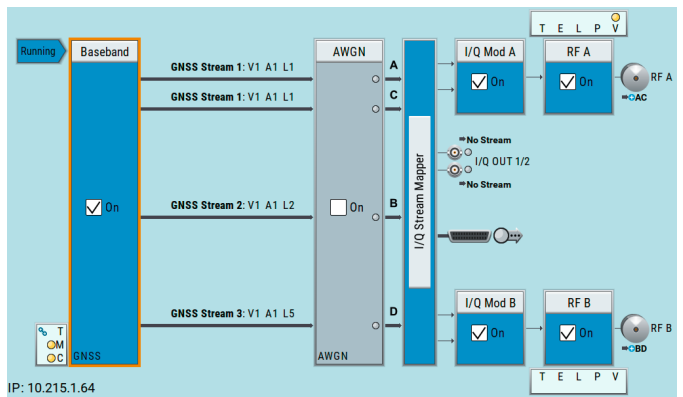
The R&S®SMW200A can be operated as a pure GNSS simulator. Above: simulation of GPS (L1 C/A, L1 P, L2C, L5), Galileo (E1 OS, E5a, E5b), GLONASS (L1 C/A, L2 C/A) and BeiDou (B1I, B2I)

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A multitude of different scenarios with GPS, Galileo, GLONASS and BeiDou signals can be generated in real time with up to 144 channels. For the receiver, the simulated location can be static, but users can also import waypoint files to set up moving scenarios. Even changes of the vehicle's attitude can be simulated. The antenna pattern can be changed individually and also the installation location can be set. Potential shadowing caused by the housing of the antenna can be modeled with vehicle body mask files.

Configuring multi-frequency scenarios
For multi-frequency scenarios, the R&S®SMW200A has an integrated second RF source. This makes it possible to simultaneously generate signals for all important GNSS frequency bands, such as L1, L2 and L5, out of one box. Different ionospheric models can be applied to evaluate the error mitigation capabilities of multi-frequency receivers. Standard models, such as the Klobuchar model used by GPS or the NeQuick model proposed by Galileo, are available, but also historical models can be loaded. When conducted testing is performed on multi-frequency receivers, all output signals are added in a combiner and then fed into the antenna port of the receiver. Alternatively, receiv-

ers can be tested over the air (OTA) in a shielded chamber. The test signals are then provided to the GNSS receiver via multiple antennas inside the chamber.

Using multiple GNSS constellations
The R&S®SMW200A can generate signals for up to 144 channels from different GNSS to support receiver tests with complex test signals. This way, realistic scenarios, where SVs from all GNSS are present, can be easily set up.

Example			
System	No. of SVs	Signals	No. of channels
GPS	8	L1 C/A, L1 P, L2C, L5	8·4 = 32
Galileo	8	E1 OS, E5a, E5b	8·3 = 24
GLONASS	7	L1 C/A, L2 C/A	7·2 = 14
BeiDou	9	B1I, B2I	9·2 = 18
Total	**32**		**88**

If the test case requires a mixed GNSS signal with predefined minimum and maximum number of satellites, these limits can be set per GNSS. Additionally, all satellites can be manually switched on or off on-the-fly, i.e. the simulation is not interrupted.

It is also possible to vary the individual power levels or assign pseudorange errors to each satellite in real time. This can be used to test the receiver autonomous integrity monitoring (RAIM) capabilities of a receiver. The real-world situation of disappearance and reappearance of satellites can be observed on the built-in simulation monitor (see figure at the bottom left).
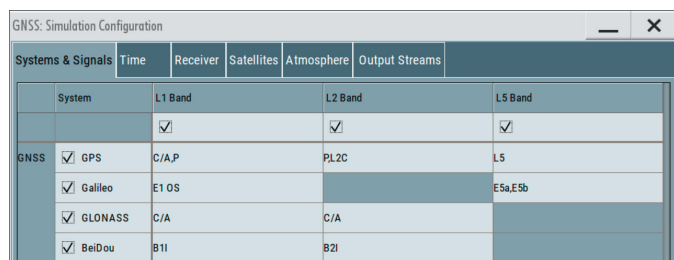

Multi-frequency, multi-constellation scenarios, can be configured in an easy, user-friendly and efficient way with the GNSS simulator in the R&S®SMW200A

GNSS constellations and satellite power levels can be observed in the built-in simulation monitor

Benefits and key features
The R&S®SMW200A is the perfect solution for testing your multi-frequency, multi-GNSS receiver. It ensures realistic and repeatable test conditions in a controlled lab environment with the following key features:
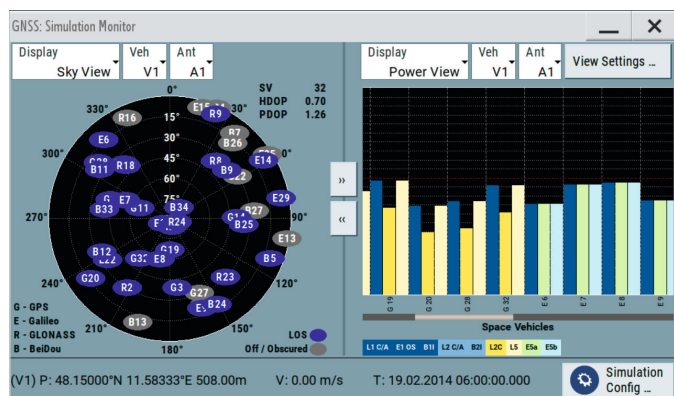▪ Support of multi-constellation scenarios with up to 144 channels
▪ Support of all important GNSS
  ・ GPS L1/L2 (C/A and P code), L2C, L5
  ・ GLONASS L1/L2 C/A code
  ・ Galileo E1, E5a, E5b
  ・ BeiDou B1I/B2I
  ・ QZSS L1 C/A
▪ Easy configuration of multi-frequency GNSS scenarios

See also
www.rohde-schwarz.com/product/smw200a